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(58) Field of search
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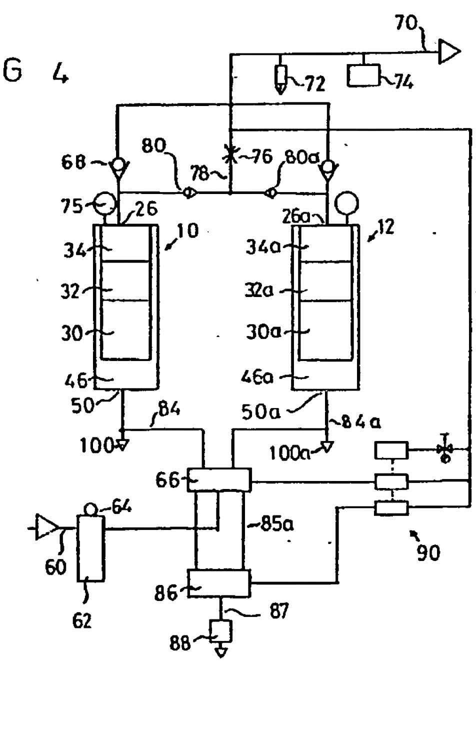
(54) **Compressed gas purifier**

(57) A compressed gas purifier, particularly for breathing air, uses a pair of multi-section contaminant absorbing units 10, 12 connected for pressure swing adsorption, in which the inlet valves are mechanically interconnected; in one embodiment the inlet valve means is a shuttle valve 66 with three sealing lands mounted on a common shaft, the shaft providing the mechanical interconnection, for control of the flow of compressed air to one unit at a time. In another, said valve means is a rotary valve having first and second angular positions.

A timer 90 includes an air motor (92) which effects changeover of inlet valve 66 and purge valve 86. The timer regulator (98) may be replaced by a manual valve changeover system e.g. one dependent on the observation of the colour of contaminant indicator strips (40).

The purge gas flow assists in removal of gravitational water droplet flow. Drain valve 100, 100a is opened before water build up visible in sump 46, 46a can reach the desiccant in units 10, 12.

FIG 4



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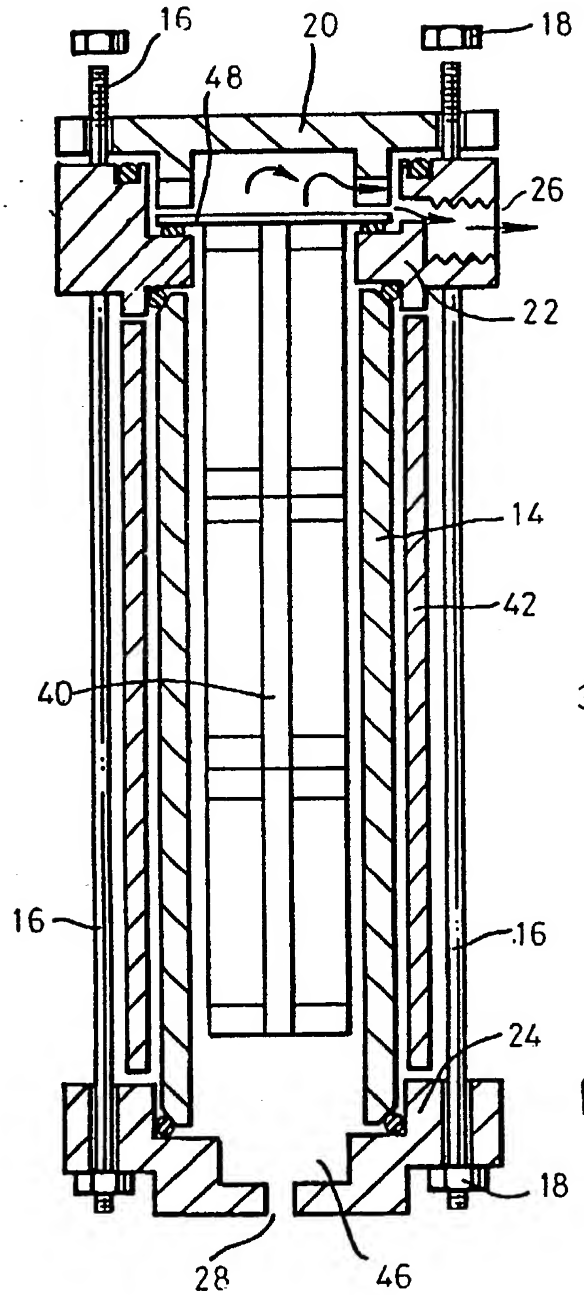

FIG 1

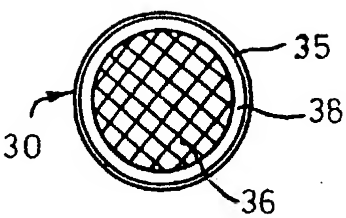

FIG 2

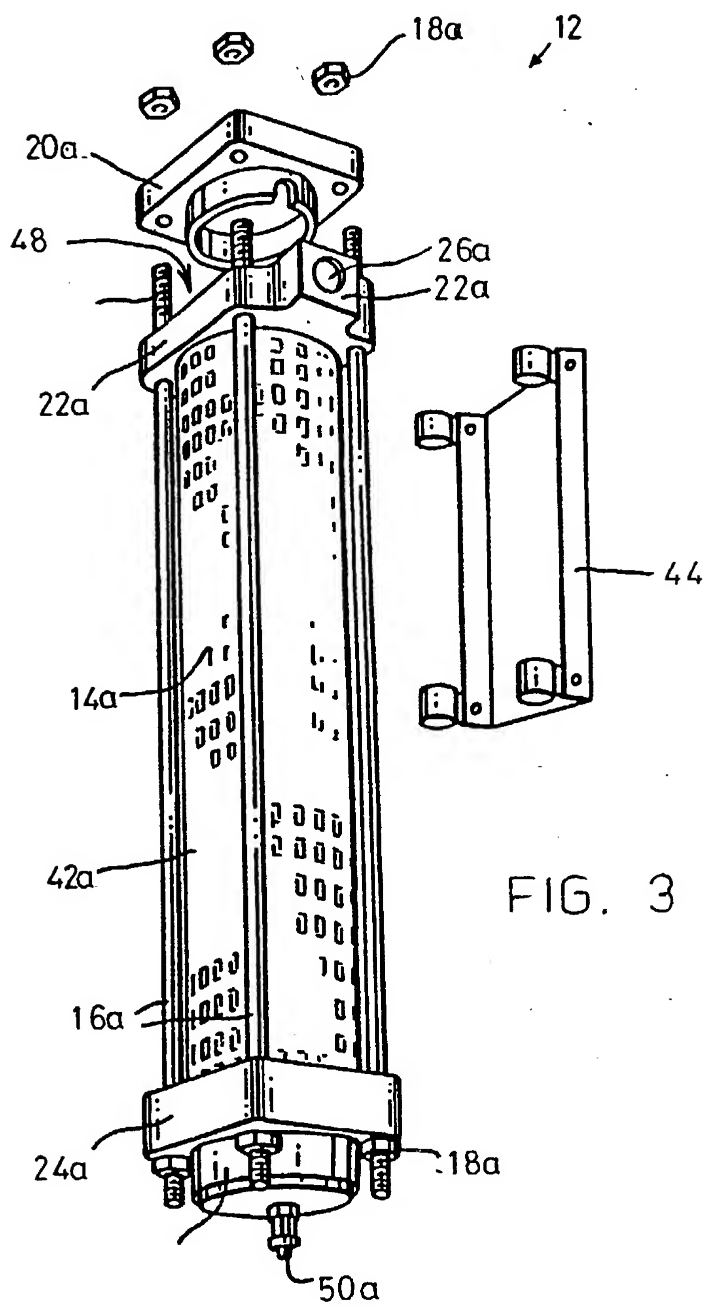

FIG. 3

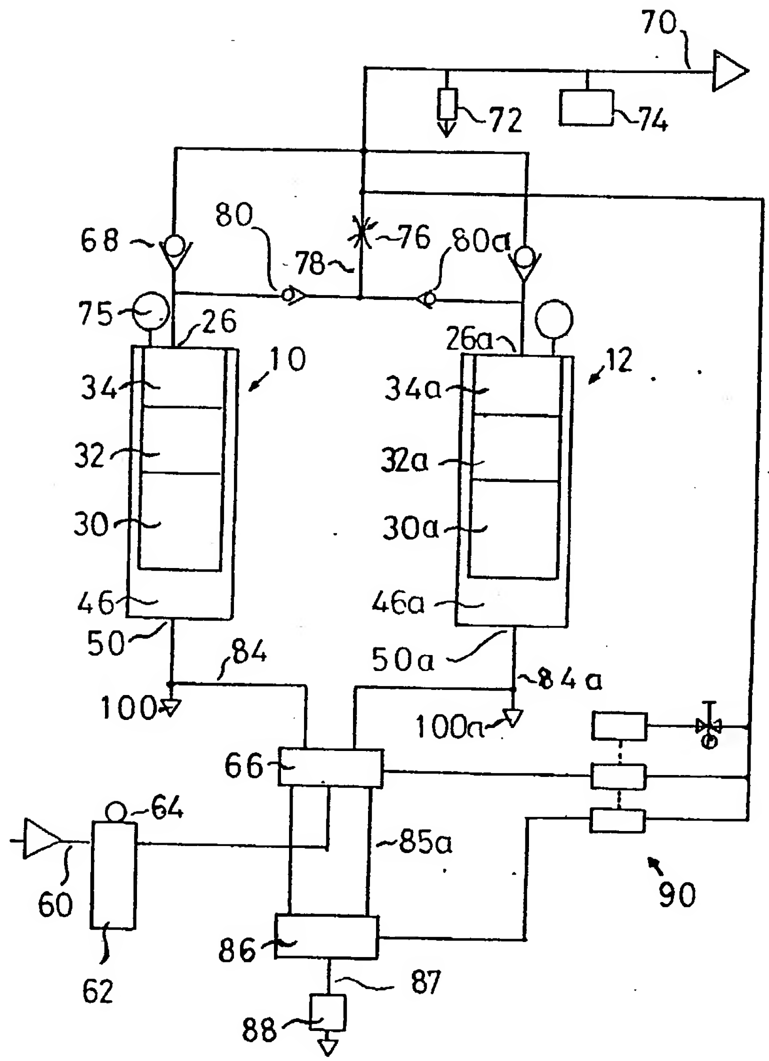
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FIG 4

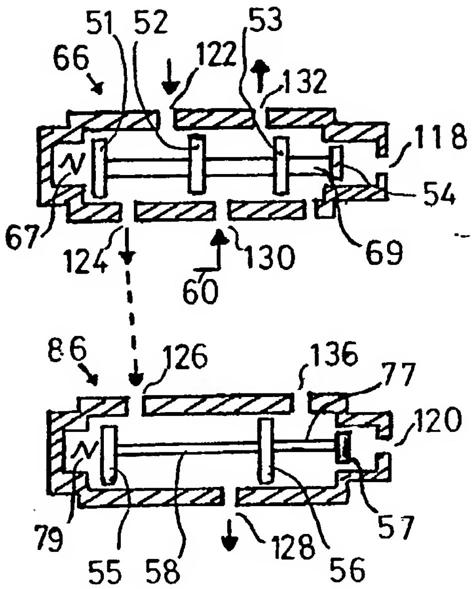

FIG 5

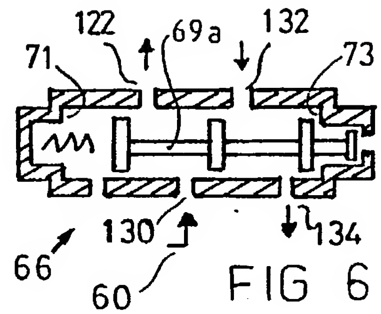

FIG 6

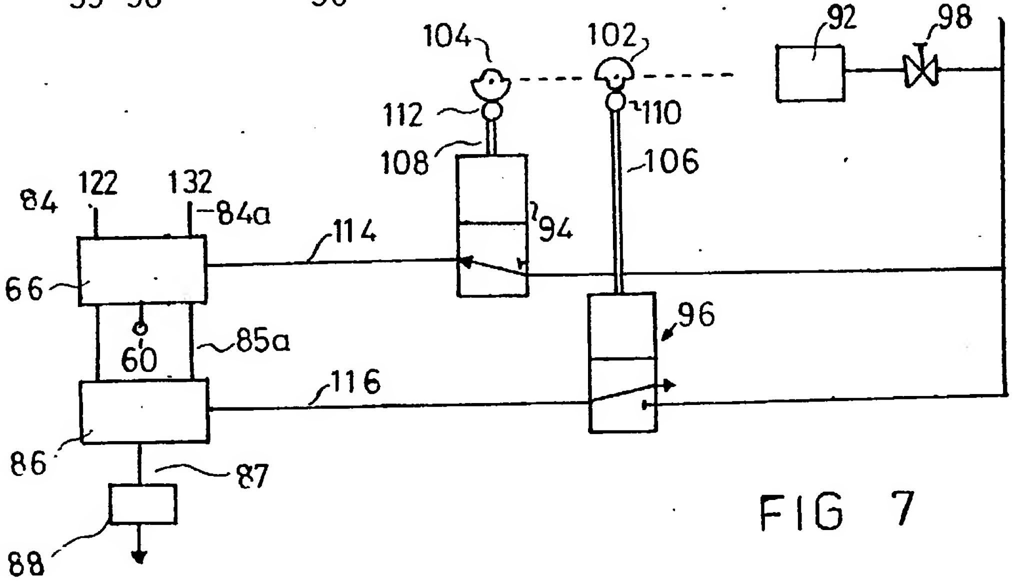

FIG 7

COMPRESSED GAS PURIFIER

This invention relates to a compressed gas purifier, and relates in particular to an apparatus and method for purifying compressed breathing air.

Systems using "piped" breathing air have been widely adopted in industry, being used principally to reduce the dangers to workers operating in a hazardous breathing environment such as a paint spraying booth. Typically, atmospheric air will be drawn into a compressor, pressurised to 80-100psi, and conducted in a ring main pipe to an operator air point adjacent each work station; the operator will use a face breathing mask, which includes a flexible pipe which he connects to the air point. Pressure reduction means at the air point will reduce the air pressure in the flexible pipe (and thus in the operator's face mask) to a suitable breathing value.

One problem with compressed breathing air systems is that the atmospheric air drawn into the compressor will frequently contain a number of contaminants, especially water vapour which when the air is compressed will often phase change to form water droplets; and this change of state from vapour to liquid will be accentuated if the compressed air drops in temperature after leaving the compressor.

To help reduce this problem, compressed breathing air systems

are used wherein the compressed air is passed through a (water removing) desiccant on its way to the operator air point, with the system being "closed down" at frequent intervals so that the desiccant container can be removed, either to allow desiccant replacement, or for the desiccant to be dried in in its container by being heated under conditions to drive off the water. Interval replacement of a desiccant can however introduce its own problems in that if if the interval is set too long then the desiccant will absorb too much water before being replaced and may form a coagulated mass, gradually reducing the air flow to the operator as well as becoming difficult to remove.

To help reduce the problem thus created, it is known to provide a two-unit drying apparatus, such as that of US Patent 2703628; the apparatus there disclosed permits one of the units to be heat-regenerated whilst the other unit is drying gas; however it is taught that the gas to be dried is fed into the top of the duty unit, so that the desiccant is required not only to adsorb the water carried in the gas as vapour but also to absorb that entrained or deposited as water droplets and which seeks to gravitate down through the desiccant, saturating the desiccant, usually causing it to bind together and so becoming difficult to remove and replace. If any excess "free" liquid is not removed during the purge cycle, the dryer soon becomes waterlogged and ineffective. Capacitors are to be used to check the moisture content at the top and bottom of each unit, but these require electrical wiring within the units, which in a wet and perhaps

explosive environment could be hazardous.

A modified arrangement of two-unit apparatus, used for fractionating gaseous mixtures, is known from Skarstrom US Patent 2,994,627, which teaches diverting some of the purified gas from one unit for use as (low-pressure) purge gas in the other unit. However, his arrangement suffers the disadvantage that the purge gas outlet valves are between the respective units and their inlet valve means (which control the flow of pressurised gas to each unit), so that his inlet valves are expected to operate whilst continually wetted by and perhaps submerged in liquid condensate, and may (dangerously) stick in position.

A further problem with breathing air systems is that the air drawn into the compressor may include toxic vapours, whilst the compressor itself may produce others e.g. carbon monoxide fumes. I have therefore already proposed an arrangement (which I have disclosed in my U.S. Patent 4746338) in which the breathing air to be purified is passed upwardly through a multi-section unit, each section containing at least one air purifying material effective to remove a respective (different) contaminant from compressed breathing air passing through the unit. Each section can retain the material dust which may arise from material degradation, so that a downstream dust filter may not be necessary; and each section (desiccant, catalyst etc) can be replaced at its specified "exhaustion" date without need to discard the other sections.

Yet a further problem with breathing air apparatus is the need to provide a continuous supply of air at substantially constant pressure to the ring main; not only does this ensure continuity of production, but each operator necessarily relies on the ring main air for his breathing air, so a curtailed supply can be unpleasant and perhaps dangerous. The arrangement of my U.S. Patent 4746338 discloses a housing which has a removable closure cap at one end, to permit quick insertion and removal of the "filter" sections; however, such removal and replacement of the sections, even if quickly accomplished and even if infrequently needed, can still cause an unacceptably long interruption in the breathing air flow.

I now propose a compressed gas purifier, and in particular a compressed breathing air purifier, which seeks to avoid or reduce the above problems. It will be understood that my purifier may also be used to remove some or all of specified constituents from a gas for which the product gas flow should not be interrupted, and may also be used as a gas fractionating apparatus (with removal and separate regeneration of individual sections, and the separate retention of the adsorbed gas).

Thus I propose compressed gas purifier which includes

1. a source for compressed gas to be purified;

2. first and second contaminant-adsorbing units, each said unit having an inlet and an outlet, the outlet being above the inlet;

3. first conduit means extending between said source and the inlet of the first unit, and second conduit means extending between the source and the inlet of said second unit;

4. first inlet valve means in the said first conduit, and second inlet valve means in the said second conduit, said inlet valve means effecting a connection or disconnection between the source and the respective unit inlet;

5. means to operate the said first and second inlet valve means;

6. first purge inlet valve means controlling the flow of purge gas from the outlet of the first unit to and into the outlet of the second unit to permit the counterflow of purge gas through the second unit, and second purge inlet valve means controlling the flow of purge gas from the outlet of the second unit to and into the outlet of the first unit to permit the counterflow of purge gas through the first unit;

7. first purge outlet valve means to control the outflow of purge gas from the said first unit, and second purge outlet

valve means to control the outflow of purge gas from the said second unit;

8. and first timing means to permit opening of the first inlet valve means to provide the said connection only after closure of said first purge outlet valve means, and second timing means to permit opening of the second inlet valve means to provide the said connection only after closure of said first purge outlet valve means;

characterised by a first mechanical inter-connection between said first and said second inlet valve means whereby a connection in one of said first and second conduits is accompanied by a disconnection in the other of said conduits.

Usefully there will be a drain port for each unit, each drain port alternately providing for its respective unit an inlet for a compressed gas to be purified, and an outlet for said purge gas.

Preferably the conduit means will include a two-position transfer (inlet) shuttle valve for alternating the flow of gas e.g. compressed (breathing) air, to be purified to first one and then to the other of said units; and a two-position purge shuttle valve concurrently open to the other of the drain ports whilst the said one drain port is open to the compressed (breathing) air supply; the shuttle transfer valve ensures that the supplied air always flows through one or other of the units, to maintain the

flow to the operator air point and thus to the operator. The (lower pressure) purge air flowing from the drain port towards the purge valve can carry with it not only gaseous and vapour contaminants dis-adsorbed from the second unit, but also help remove surface water (a) from the unit sump, (b) from the pipework "downstream" (relative to the purge gas flow direction) of the drain port, and (c) from the inlet and shuttle valves.

After pressurised (breathing) air has been flowing for example through the first unit for the required time, usually I will arrange for the respective purge valve (e.g. of the second unit) to be closed prior to change-over of the transfer valve, to allow the pressure in the second unit to build up steadily towards operator line pressure (i.e. that pressure in the pure breathing product air line to the operator point), since the purge air will still continue to flow into the second unit. Thus, upon change-over of the transfer valve there is minimum, if any, mechanical pressure shock to the contents, or drop in operator (output) line pressure.

Preferably my purge valve is "upstream" relative to purge flow direction of a flow limiting valve such as a partly-open adjustable spring-opposed needle/ball valve. This flow limiting valve is fitted because at the time the purge valve is closed to the second unit (as described in the preceding paragraph), it has also been opened to the first unit, thus opening a connection from the fully-pressurised unit to atmosphere; too rapid

decompression of the first unit could perhaps rupture the purifying materials e.g. desiccant beads, and reduce their utility and create material dust settlement in the internal filters, and in the valves and pipework, and which in turn could restrict breathing air flow to the operator. The flow restrictor acts to limit the decompression rate, but at low pressure allows the full purge flow, without substantial restriction. With such pressure-responsive flow limiting valve fitted, the purge flow passage through the conduits, inlet transfer valve and purge outlet valve can be made of relatively large diameter, with minimum "back" pressure (pressure drop); the purge air passing through the unit being purged can thus be substantially at atmospheric pressure.

Preferably the timing of the changeover of the flow transfer valve and of the purge valve will be automatically controlled by a timing motor, usefully a pneumatically-operated motor to exclude the explosion risk when treating flammable gas (or operating in flammable atmospheres), and to avoid the need for an electrical supply. Alternatively if fully automatic operation is not required, the controls can be arranged for manual operation.

Preferably both units are multi-stage cartridge units as disclosed in my U.S. patent 4746338.

Thus I also propose a method for purifying compressed gas, such as breathing air, which includes a pair of adsorbent

multi-section cartridges through which compressed gas to be purified is alternately passed in a regular cycle, and in which one of the cartridges is regenerated by the backflow of a portion of the purified gas through it at a relatively low pressure while the other cartridge is purifying the compressed gas, the said portion being purge gas characterised in that the compressed gas is arranged to flow in the said other cartridge in a direction opposed to the gravitational direction of water droplet flow towards a water drain, the purge gas being arranged to mass flow in the direction of water flow towards the drain whereby the purge gas flow can assist in the removal of water droplets through the drain port, and in that the flow of compressed gas to the units is controlled by a pair of valves coupled together and biassed so that one valve is open whilst the other is closed.

I am thus proposing an apparatus and method for continuously purifying compressed gas such as compressed breathing air, without the need for applied heat (though heat can also be used if desired); the purification being continued automatically by regular transfer between two (or more) purifying units of the compressed breathing air to be purified, and of purified purging air. The apparatus and method is intended to be "fail-safe" in providing a continuous compressed breathing air flow for an operator, at optimum pressure, including mechanical coupling and resilient bias of the valving, particularly of the inlet or transfer valving. The adsorbed "contaminant" can be "recovered", to permit gas fractionating if required.

The invention will be further described by way of example with reference to the accompanying drawings, in which:-

Fig.1 is a side view of an assembled three section multi-stage compressed breathing air purifier cartridge, suitable for use in the invention, inside a unit housing;

Fig.2 is an end view of the purifier cartridge of Fig.1;

Fig.3 is a perspective view of a unit housing in which a second air purifier, identical to that of Fig.1, is mounted;

Fig.4 is a schematic piping diagram of a two-unit compressed breathing air purifying system.

Fig.5 is a schematic view, partly in section, of the transfer and purge valves;

Fig.6 is of the transfer valve of Fig.5, but in another operative position; and

Fig.7 is a schematic view of a motor system suitable for use in the invention.

A breathing air purifying unit 10 suitable for use in the continuous, automatic two-unit system of Fig.4 is shown in Figs 1-3. Fig.4 includes two such units (10,12) for which equivalent parts carry the same numbering but with suffix "a". In the preferred embodiment as described in relation to Fig.4, both units 10,12 are identical i.e. of the same external shape, internal volume, and contained quantities of constituents.

As indicated in Fig. 1, unit 10 is mounted vertically. It comprises a pressure vessel 14 clamped by elongate studs 16 and nuts 18 between closure cap 20, upper end ring 22 and lower end ring 24. In this embodiment, upper end ring 22 includes port 26 as the outlet for pressurised breathing air; but in an alternative embodiment port 26 can be in closure cap 20. Lower end ring 24 includes drain port 28, also for an inlet 50,50a (Figs.2/4) for pressurised breathing air to be purified.

Within pressure vessel 14 is an elongate cartridge comprising transparent plastics container sections 30,32 and 34 in end-to-end array, the sections being interconnected so that compressed air entering the lower end of section 30 will exit from the upper end of section 34. Section 30 contains a desiccant material, section 32 contains a different air-purifying material such as activated charcoal to remove hydrocarbons, and section 34 contains another different air-purifying material, for instance catalyst to remove carbon monoxide. The purifying material can be in granular, rigid porous block or powdered form, and to

prevent its escape the material is contained in its respective section by fine mesh retaining screens 36, which are held in position by end caps 38. Each section has internally a contaminant colour-change indicator strip 40; in this embodiment vessel 14 is also of a transparent plastics material so that the indicator is visible through the walls of the vessel 14 (so that the user can check the level or height reached by the adsorbed contaminant in that section, to give an immediate indication of correct function when the purifier is fully operational), but in an alternative embodiment the vessel 14 is of metal e.g. Aluminium, so that the contaminant level is checked after section removal from the vessel. The strip in section 30 may for instance include cobalt chloride or other reversible indicator which progressively changes colour when wetted, the strip being secured against movement in the air flow.

A protective sleeve in the form of an open mesh 42 is fitted around the pressure vessel. Each unit 10,12 can be wall mounted by using a wall bracket 44 as shown in Fig.3, in this embodiment with straps/clips which clamp around elongate studs 16.

The multi-section cartridge extends co-axially inside the pressure vessel 14, being of length to leave a small drain sump 46 at the lower end of pressure vessel 14.

To replace a cartridge, after renewing some or all of sections 30,32,34, nuts 18 and closure cap 20 are removed; whereupon a new

cartridge can be lowered into place, cap 20 replaced and nuts 18 tightened to effect an air-tight seal between cap 20, flange 48 and upper end ring 22. In this embodiment flange 48 is part of section 34; but in an alternative embodiment is part of a separate mounting piece.

As seen in Fig.3, drain port 28 has nipple 50 located therein, nipple 50 acting alternately as a compressed air inlet member and as a purge air exit member, depending upon whether the unit 10 is currently on a duty cycle or a purge cycle.

As seen in the schematic piping arrangement of Fig.4, feed air from a compressor (not shown), in this embodiment at 7 bar, is introduced along supply line or source 60, and through a filter 62 to remove suspended particulate matter. Pressure-drop gauge 64 measures the loss of feed air pressure in filter 62, an excessive pressure drop warning that the filter 62 is becoming clogged and needs replacement.

Transfer valve 66 in this embodiment includes a flip-flop shuttle 69 (Fig.5) comprising shaft 69a and lands 51,52,53, and pneumatic piston 54. Shuttle 69 has alternate "left hand" and "right hand" positions (in the valve cylinder), being biassed towards the right-hand position by spring 67; but in an alternative embodiment is a rotary valve having corresponding first and second angular positions. The cylinder of transfer valve 66 includes shoulders 71,73 which define the end positions

for shuttle 69 i.e. the "left hand" and "right hand" positions. Pneumatic piston is of an area such that air at the prevailing pressure from line 114 (Fig.7) and as described in more detail below can (when connected to port 118) move pneumatic piston 54 and thus the shuttle against spring 67 into the "left hand" position (as in the schematic view of Fig.5); in the absence of compressed air from line 114, spring 67 moves the shuttle valve to its "right hand" position (Fig.6).

With the shuttle 69 of transfer valve 66 in the "right hand" position of Fig.6, feed air (contaminated compressed air) from supply line 60 will flow by way of ports 130 and 122 and between lands 51,52 of transfer valve 66 (and which thereby form the first inlet valve means) towards nipple 50 of unit 10, into sump 46 and then successively through cartridge sections 30,32,34. Purified product air will flow out from the unit 10 outlet provided by port 26 (Fig.1), through one-way line valve 68 and so into air outlet line 70, usually to an operator connection point (not shown). Outlet line 70 includes a (high pressure) safety valve 72 and a low pressure alarm 74. Unit 10 includes a gauge 75, to indicate the pressure in the unit, which in this embodiment is 7 bar.

In accordance with the setting of an adjustable purge flow control valve 76 (Fig.4), a minor proportion of the purified (product) air from downstream of the one-way line valve 68 flows into conduit 78, through one-way check valve 80a, and hence

through port 26a (Fig.3) into unit 12, for regeneration of unit 12 i.e. control valve 76 and check valve 80a provide first purge inlet valve means. This minor proportion is substantially at atmospheric pressure, and passes in turn through cartridge sections 34a, 32a and 30a. Contaminants adsorbed or absorbed by the materials in these respective sections on a previous cycle (when unit 12 was a duty unit) pass into the purge air because the vapour pressure of that contaminant is higher than the purge air pressure.

The purge air, now including contaminants, emerges from nipple 50a and flows in conduit 84a into port 132 and out of port 134 (of transfer valve 66); and then flows in conduit 85a to port 136 of purge valve 86. Purge valve 86 includes shuttle 77 having shaft 58 carrying sealing land 55, spring abutment 56 and pneumatic piston 57. If shuttle is pneumatically biassed to its "left hand" position, purge air flows from port 136 to port 128i.e to the right (as seen in Fig.5) of land 56.

It will be understood that shuttle 77 of purge valve 86 will move to the "right-hand" position as seen in Fig.5, in the absence of pressure from line 116 (Fig.7) and under the action of spring 79, permitting purge air flow through ports 122,124,126 and 128, as schematically shown in Fig.5.

Downstream (in the direction of purge air flow) of purge valve 86, the purge air flows through conduit 87 and passes through

flow limiting valve 88, to dump to atmosphere. It will thus be further understood that the purge air can help remove for instance not only water vapour from the desiccant material in section 30a, and organic vapours and compounds, but also surface water deposited during a previous cycle, particularly from within the sump 46a, conduits 84a,85a, transfer valve 66, purge valve 86 and flow limiting valve 88. In this embodiment liquid flow is gravity-assisted because of the vertical disposition of the units and valves.

The operative direction of "purge" flow through the sections 34a,32a,30a is opposite to the direction of "duty" flow through the sections 30,32,34.

A timer, generally indicated in Fig.4 by arrow 90, includes a pneumatically-driven motor 92, which effects changeover of valves 66,86 by way of respective pneumatic drivers 94,96. The frequency of valve changeover is controlled by the selection of gearbox and cams, and is tuned by regulator 98. In the embodiment as seen schematically in Fig.7, the air motor 92 rotatably drives a pair of coupled cams 102,104, which in turn operate resiliently-biassed reciprocating control rods 106,108 by way of respective cam followers 110,112. The control rods are connected to on/off valves in lines 114,116 leading respectively to transfer valve control port 118, and purge valve control port 120. The timing of the transfer valve and purge valve flip-flop movement is dependent on the cam forms, the relative cam angular

positions and their angular velocity; in an alternative embodiment the cams 102/104 can be replaced by cams of different profile and/or their relative angular position and velocity can be changed.

An important feature of this invention is that pneumatic driver 96 is arranged to transfer purge valve 86 to its opposed position just before pneumatic driver 94 causes changeover of transfer valve 66. Thus, upon movement of shuttle 77 of purge valve 86, to the "left hand" position of Fig.5, the pressure in unit 12 gradually builds up towards system pressure i.e. the pressure in line 70, since unit 12 is still being fed with the minor proportion of the product air through port 26a. Thus when transfer of valve 66 (shuttle 69) is effected, in this example from the "right hand" position of Fig.6 to the "left hand" position of Fig.5, there is not a sudden drop in the product air pressure in line 70 (which might prove dangerous to an operator), nor is there a sudden increase in pressure in unit 12 (which could cause damage to the contents by mechanical pressure shock).

In the embodiment as described, this operator and system safety feature means that when transfer valve 66 is moved to its opposed position, in this example as mentioned above from the "right hand" position to the "left hand" position, air under pressure from unit 10 can flow back out through nipple 50, ports 122,124 of valve 66 and ports 126,128 of purge valve 86, and conduit 87

to atmosphere.

To ensure that this flow and the resulting decompression does not occur too quickly, with possible explosive escape of entrapped gases, and disintegration of the materials in one or more of sections 30,32,34, this speed of out-flow is controlled by flow limiting valve 88. In an alternative embodiment with temporary and intermittent flow limiting, the flow limiting valve 88 is replaced by a flip-flop flow speed control valve (which can be identical to the purge valve 86 but with modified piping connections) i.e. wherein conduit 87 is connected to the equvalent of port 128, the equivalent to port 126 is connected to atmosphere and the equivalent to port 136 is connected to a flow limiter; after initial (slow flow speed) decompression of a former duty unit with the purge flow inhibited by the flow limiter, the control pressure is applied so that the shuttle of the flow speed control valve is moved to its full flow position with substantially unrestricted purge flow. The shuttle of the flow speed control valve can be changed in flip-flop fashion by motor 92, as for the transfer valve 66 and purge valve 86.

In an alternative embodiment timer 90 can include a manual over-ride, should regulator 98 (which will normally be set prior to delivery to the user) give too infrequent a changeover for the duty required of a unit under particular circumstances. In yet a further embodiment, timer 98 can be replaced by a manual valve changeover system, perhaps dependent on observation of the colour

change of contaminant indicator strips 40.

Excessive water which has built up for example in sump 46 can be removed, without dismantling a unit, by the manual opening of dump valve 100 in line 84 (or 100a in line 84a) as required. The sump 46 provides a safety zone to reduce the likelihood that some of the desiccant even temporarily will be standing in water, should for instance there be a sudden large condensation phenomena arising from a combination of high humidity in the air drawn into the compressor, and low ambient temperature at the units. Discharge through dump valve 100 can be assisted if required by creating a small air pressure head in the unit.

The manual drain valves 100,100a also allow the units to be completely de-pressurised should maintenance work be required.

An advantage of the timer disclosed is that it is fully pneumatic and does not therefore create a hazard (e.g. a spark) in explosive atmospheres. I do not however exclude alternative embodiments wherein the timing of valve 66 changeover is initiated in response to the pressure monitored by gauge 75,75a respectively i.e. when the "purge" unit is at or sufficiently near to the existing pressure in line 70 (or as monitored by the other of gauges 75,75a for the current "duty" unit, this being effected preferably mechanically but alternatively electrically. I may also arrange for a graphical output record to be kept of the pressures recorded by gauges 75,75a over a set period.

I have thus disclosed a continuously operating compressed air purifier, by the alternate regeneration of each of two multi-section purifier cartridges i.e. the concurrent regeneration of all the sections of a unit, typically in a three-stage unit (a) activated charcoal and (b) a catalyst as well as (c) a desiccant. As disclosed two multi-section cartridges are used, each in a separate housing; but more than two can be used, and in a single housing provided there are means to keep apart the compressed feed air and the purge air. The sump 46 is visible through the vessel walls so any water build-up can be seen, before the water level reaches the desiccant in the duty unit; and the drain valve 100 can then be opened, for example before the desiccant can coagulate and cut off the air flow to the operator.

CLAIMS

1. Compressed gas purifier which includes

   1. a source for compressed gas to be purified;

   2. first and second contaminant-adsorbing units, each said unit having an inlet and an outlet, the outlet being above the inlet;

   3. first conduit means extending between said source and the inlet of the first unit, and second conduit means extending between the source and the inlet of said second unit;

   4. first inlet valve means in the said first conduit, and second inlet valve means in the said second conduit, said inlet valve means effecting a connection or disconnection between the source and the respective unit inlet;

   5. means to operate the said first and second inlet valve means;

   6. first purge inlet valve means controlling the flow of purge a gas from the outlet of the first unit to and into the outlet of the second unit to permit the counterflow of purge gas through the second unit, and

second purge inlet valve means controlling the flow of purge gas from the outlet of the second unit to and into the outlet of the first unit to permit the counterflow of purge gas through the first unit;

7. first purge outlet valve means to control the outflow of purge gas from the said first unit, and second purge outlet valve means to control the outflow of purge gas from the said second unit;

8. and first timing means to permit opening of the first inlet valve means to provide the said connection only after closure of said first purge outlet valve means, and second timing means to permit opening of the second inlet valve means to provide the said connection only after closure of said first purge outlet valve means;

2. characterised by a first mechanical inter-connection between said first and said second inlet valve means whereby a connection in one of said first and second conduits is accompanied by a disconnection in the other of said conduits.

3. Compressed gas purifier according to Claim 1 characterised by a second mechanical inter-connection between said first purge outlet valve means and said second purge outlet valve

means whereby permitted outflow of purge air from one of said first and second units is accompanied by a forbidden outflow of purge air from the other of said units.

4. Compressed gas purifier according to Claim 1 or Claim 2 characterised in that the first inlet valve means is positioned between the inlet to the first unit and the first purge outlet valve means, and in that the second inlet valve means is positioned between the inlet to the second unit and the second purge outlet valve means, whereby purge gas must flow through through the respective inlet valve means before reaching its associated purge outlet valve means.

5. Compressed gas purifier according to Claim 1 characterised in that the first and second inlet valves are provided by an inlet shuttle sealingly movable in a inlet valve cylinder, the shuttle being biassed by an inlet spring towards one end of the inlet valve cylinder.

6. Compressed gas purifier according to Claim 4 characterised by a pneumatic inlet piston connected to the inlet shuttle at a position opposed to the inlet spring, the pneumatic inlet piston being of a cross-section to generate a force sufficient to overcome the bias of the inlet spring when subjected to the operating pneumatic pressure.

7. Compressed gas purifier according to Claim 1 characterised in that the first and second purge outlet valves are provided by a purge shuttle sealingly movable in a purge valve cylinder, the purge shuttle being biassed by a purge spring towards one end of the purge valve cylinder.

8. Compressed gas purifier according to Claim 6 characterised by a pneumatic purge piston connected to the purge shuttle at a position opposed to the purge spring, the pneumatic purge piston being of a cross-section to generate a force sufficient to overcome the bias of the purge spring when subjected to the operating pneumatic pressure.

9. Compressed gas purifier according to Claim 1 characterised in that the first and second purge outlet means are respectively between the first and second inlet valve means and a flow limiting valve adapted to inhibit the outflow of purge gas.

10. Compressed gas purifier according to any of Claims 1 to 8 characterised by pneumatic control means, said pneumatic control means including first and second cam operated valves driven by a pneumatic motor, said cams being phased to provide said first control means whereby to permit opening of an inlet valve only after closure of its associated purge valve.

11. Compressed gas purifier according to Claim 9 when dependent upon Claim 5 and Claim 7 characterised by said first cam operated valve regulating the pneumatic pressure to be fed to the pneumatic inlet piston, and by said second cam operated valve regulating the pnuematic pressure to be fed to the pneumatic purge piston.

12. A method for purifying compressed gas, such as breathing air, which includes a pair of adsorbent multi-section cartridges through which compressed gas to be purified is alternately passed in a regular cycle, and in which one of the cartridges is regenerated by the backflow of a portion of the purified gas through it at a relatively low pressure while the other cartridge is purifying the compressed gas, the said portion being purge gas characterised in that the compressed gas is arranged to flow in the said other cartridge in a direction opposed to the direction of gravitational water droplet flow towards a water drain, the purge gas being arranged to flow in the direction of mass water flow towards the drain whereby the purge gas flow can assist in the removal of water droplets through the drain port, and in that the flow of compressed gas to the units is controlled by a pair of valves coupled together and biassed so that one valve is open whilst the other is closed.

13. Compressed gas purifier constructed and arranged substantially as described in the accompanying drawings.

14. A method for purifying compressed gas substantially as described with reference to the accompanying drawings.

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